



More efficient LDPC Parity Code Matrix and downstream FEC draft text (rev 1a)



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Supporters

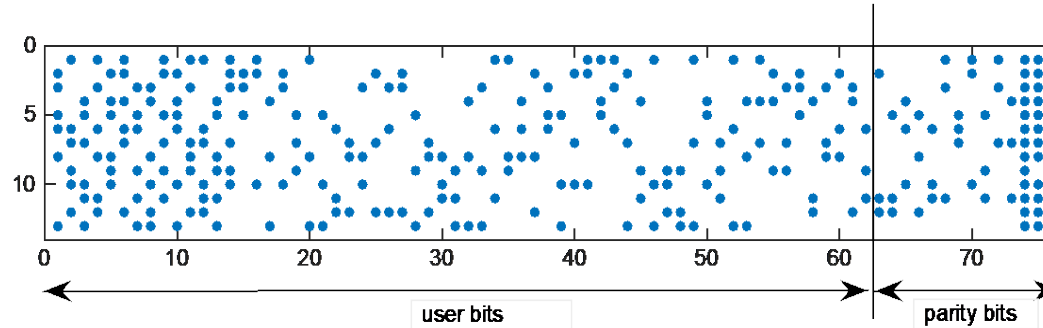
- Gaobo (Heaven), Huawei

Introduction

- The LDPC(18493,15677) [13x75x256] 0.848 FEC code was adopted for the downstream at the last meeting in Orlando. See motion #6 from [unapproved minutes](#).
 - This included a parity code matrix as presented in [laubach_3ca_1a_1117](#)
- While answering questions from other affiliations before and after the November meeting, the parity code matrix authors observed there could be some improvements made:
 - Slightly improved processing efficiency.
 - Slightly better error correction performance, especially in deep region.
 - Ability to use a “vanilla” Min Sum Decoder, with no special decoder scaling features.

More Efficient Parity Code Matrix

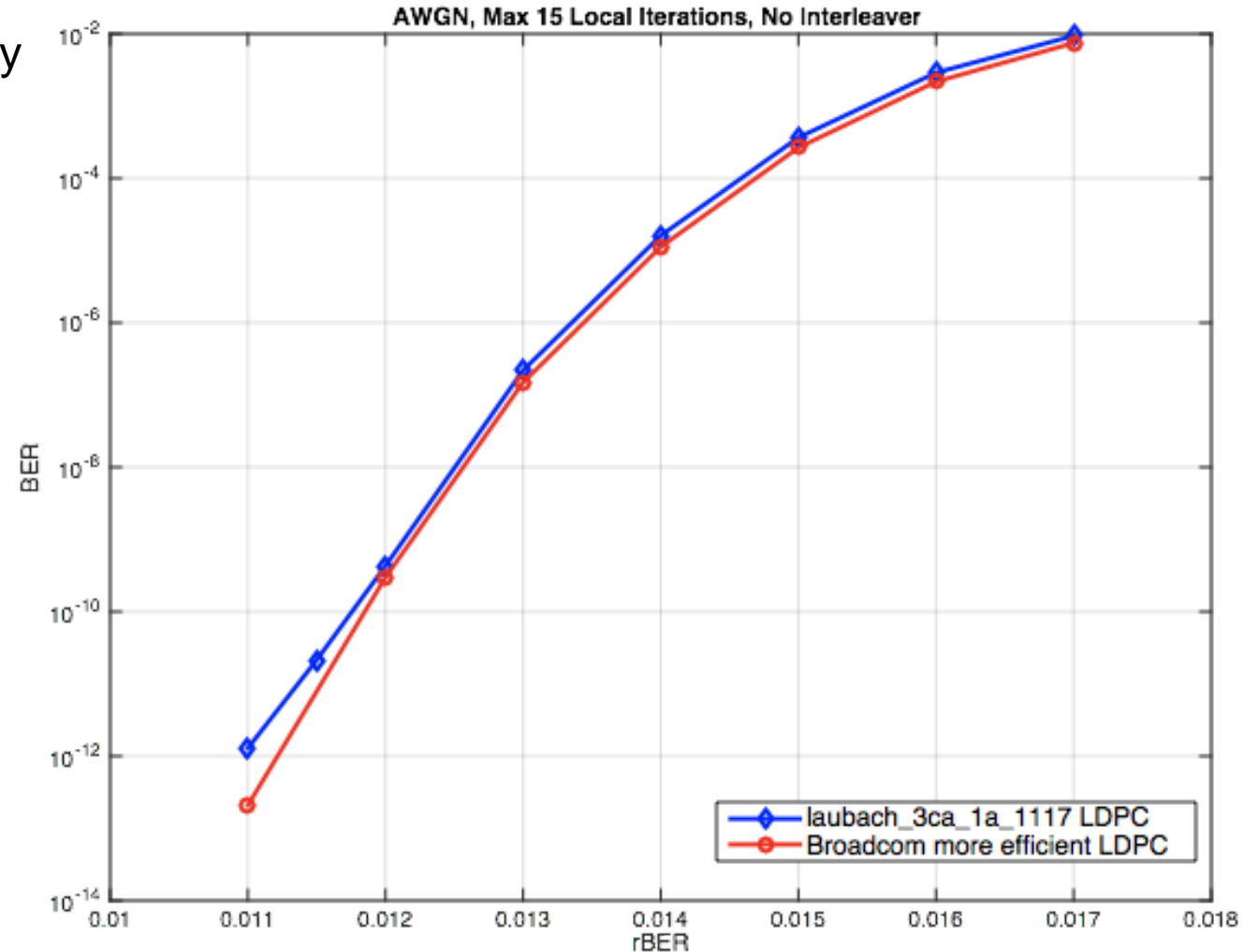
- Same matrix dimension (13x75ex256) as accepted by task force in November Orlando meeting.
- Optimized for deep region performance to simplify decoder implementation on scaling.
- Puncturing from the right side two columns (circulant columns 12 and 13).
- Shortening from the left side (195 bits).



```
-1 190 -1 134 -1 221 -1 -1 157 -1 238 87 -1 223 -1 207 -1 -1 -1 16 -1 -1 -1 -1 -1 -1 -1 -1 -1 132 0 -1 -1 -1 -1 90 53 76 -1 -1 203 -1 -1 77 -1 -1 222 -1 122 -1 -1 -1 -1 -1 -1 -1 -1 -1 23 -1 212 -1 11 -1 145 61
4 -1 -1 -1 44 173 -1 -1 5 52 -1 -1 -1 90 29 255 -1 69 -1 -1 -1 -1 -1 87 -1 132 -1 -1 -1 -1 -1 -1 -1 190 -1 -1 171 202 -1 -1 27 -1 -1 -1 -1 -1 -1 -1 -1 1232 -1 102 -1 -1 84 -1 -1 166 -1 -1 -1 -1 -1 125 -1 -1 -1 163 176
144 -1 -1 179 -1 -1 0 228 -1 -1 39 -1 -1 130 -1 -1 188 -1 -1 -1 -1 -1 242 -1 0 0 -1 -1 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 125 0 -1 29 -1 0 -1 -1 -1 -1 -1 0 -1 -1 -1 126 -1 194 117
-1 -1 154 -1 89 60 -1 169 -1 242 -1 -1 107 -1 -1 -1 105 -1 -1 -1 -1 -1 -1 -1 -1 -1 87 -1 -1 166 -1 -1 -1 -1 46 -1 -1 45 -1 -1 -1 -1 250 -1 -1 120 76 214 -1 -1 173 -1 -1 124 -1 -1 -1 130 -1 -1 -1 -1 -1 -1 222 47 119
190 -1 184 -1 158 -1 150 -1 241 45 -1 -1 195 -1 25 -1 -1 -1 173 -1 250 -1 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 84 27 -1 -1 0 -1 -1 -1 -1 41 -1 -1 -1 -1 -1 111 -1 -1 -1 -1 -1 0 -1 197 -1 -1 143 -1 0 -1 -1 234 198
250 231 -1 5 -1 80 105 -1 -1 135 -1 7 -1 -1 -1 -1 -1 -1 -1 39 -1 -1 164 -1 -1 -1 -1 -1 112 -1 237 -1 143 -1 -1 -1 -1 50 -1 -1 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 171 -1 130 -1 -1 163 -1 175 -1 125 -1 -1 -1 -1 46 53
-1 223 232 -1 -1 0 -1 -1 0 -1 0 109 -1 57 -1 -1 -1 0 -1 -1 -1 0 -1 0 -1 -1 0 -1 -1 -1 -1 -1 205 -1 -1 0 -1 -1 -1 0 -1 0 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1 0 212 209
0 -1 -1 0 166 -1 -1 214 -1 -1 215 -1 0 -1 -1 -1 0 -1 -1 -1 183 142 -1 -1 -1 -1 22 178 -1 0 -1 -1 0 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 -1 112 29
-1 121 -1 -1 174 -1 98 -1 107 -1 54 -1 102 232 -1 -1 -1 141 -1 -1 -1 -1 -1 -1 109 -1 -1 0 -1 102 -1 139 -1 -1 -1 -1 -1 -1 -1 0 -1 4 0 -1 -1 196 -1 -1 -1 0 14 -1 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 71 -1 -1 242 -1
-1 0 0 -1 0 -1 -1 0 -1 0 -1 0 -1 0 -1 0 -1 -1 0 -1 -1 -1 -1 -1 -1 0 0 -1 -1 -1 0 0 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1 0 -1 -1 0 -1 -1 -1 0 0
-1 -1 227 181 -1 -1 173 -1 156 -1 -1 126 27 -1 -1 -1 -1 -1 -1 -1 10 -1 -1 -1 -1 -1 -1 118 186 -1 -1 0 -1 -1 -1 -1 -1 -1 43 -1 -1 -1 -1 27 -1 -1 -1 -1 -1 0 -1 -1 -1 104 0 15 -1 -1 29 21 -1 -1 60 -1 24 145 24
-1 43 -1 38 -1 48 -1 217 -1 -1 159 48 -1 -1 -1 -1 -1 -1 -1 125 220 -1 185 104 10 -1 21 -1 -1 -1 -1 -1 -1 87 -1 -1 -1 -1 -1 -1 -1 0 60 -1 -1 -1 -1 -1 -1 -1 54 -1 -1 108 -1 183 29 -1 40 -1 -1 -1 -1 -1 -1 62 160
123 -1 191 -1 -1 -1 145 18 -1 247 -1 -1 101 -1 -1 -1 124 -1 -1 149 17 -1 -1 -1 -1 -1 17 -1 -1 18 238 250 -1 -1 -1 -1 -1 232 -1 -1 -1 213 -1 155 -1 168 239 -1 -1 76 221 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 19 225
```

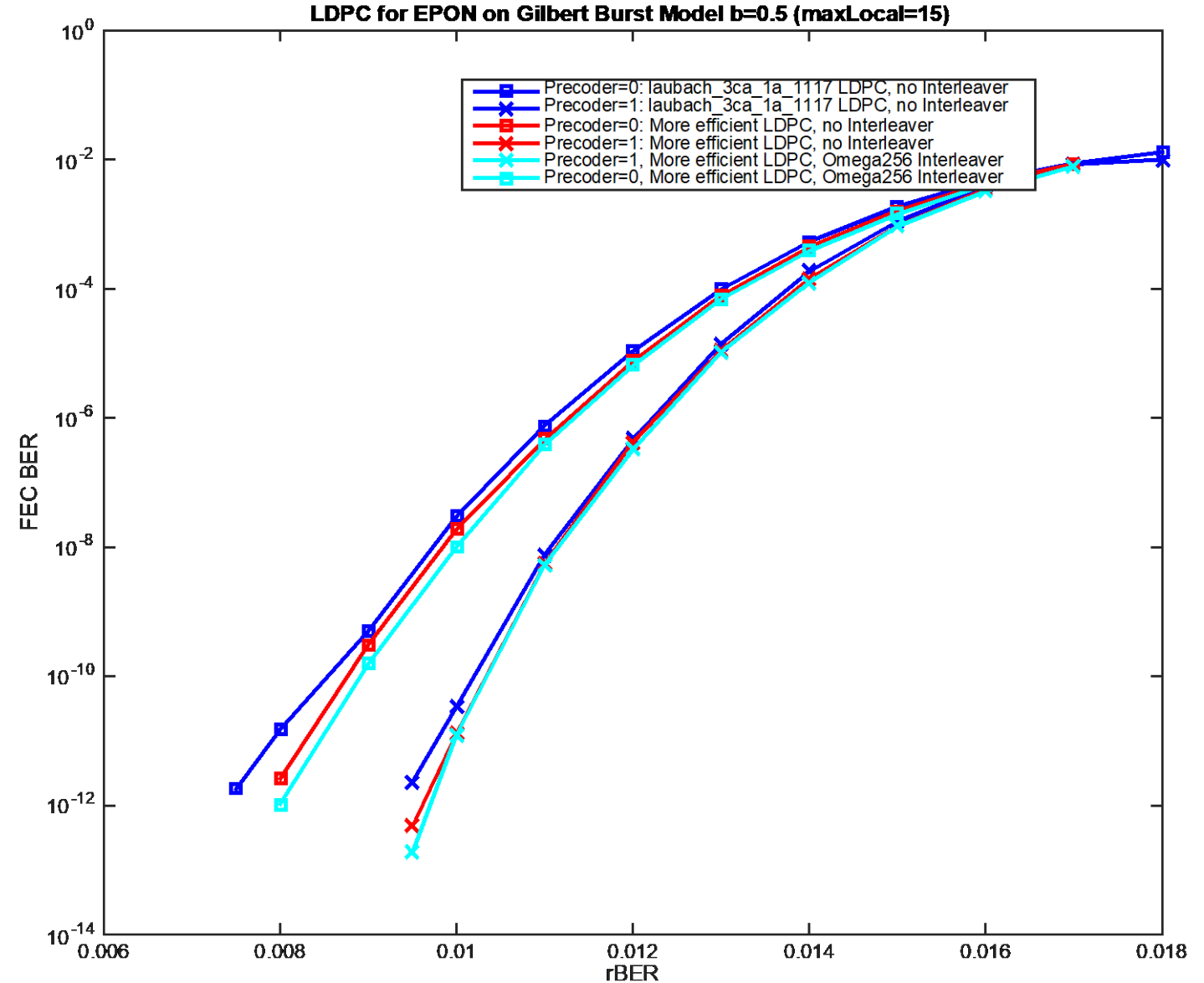
AWGN Performance

- Improved error floor performance without any fixed-point features.
- Gain improvement: 2.60 dB to 2.63 dB.
- Note: From previous presentation, using an interleaver has no impact on AWGN performance.



Gilbert Burst Model Performance

- Precoder on/off, no interleaver
- Gain improvement:
 - Precoder on:
 - 2.03 dB with interleaver (previous) to:
 - 2.11 dB without interleaver
 - **2.12** with interleaver (**rev 1a**)
 - Precoder off:
 - 1.78 dB with interleaver (previous) to:
 - 1.85 dB without interleaver
 - **1.87** dB with interleaver (**rev 1a**)



Summary of more efficient parity code matrix in this presentation

- A more efficient parity code matrix is presented with improvements over laubach_3ca_1a_1117:
 - NZ reduced from 290 to 286 -> 1.4% faster processing.
 - Slightly improved AWGN and Gilbert Burst performance.
 - Improved error floor performance without any fixed-point features.
 - Processing latency is slightly better:

LDPC	laubach_3ca_1a_1117	More Efficient
	µsec @ 15 iterations	µsec @ 15 iterations
Encoder	2.0	1.842 (encoder improvement)
Buffer	0.77	0.77
Decoder	2.175	2.145 (fewer non-zero circulants)
Buffer	0.77	0.77
Total one-way	5.715	5.527

LDPC Performance Review

	Length	Rate	Non-Zero Blocks	NECG ¹ (dB) (optical gain)		M Gates Encoder + Decoder (approximately)	Latency ² (µsec) (includes single buffer)	Reference
				AWGN	Gilbert Burst			
LDPC	(18493,15677) [13x75x256]	0.848	290	2.6 (1.82-2.34)	1.76 ³ (1.23 - 1.58) 2.03 ^{4,7} (1.41 – 1.82)	1.65 to 1.8	E 2.77 + D 2.95 = 5.72	laubach_3ca_1a_1117
			286	2.63 (1.84 - 2.37)	1.87 ³ (1.31 – 1.68) 2.12 ⁴ (1.48 – 1.91)		E 2.61 + D 2.92 = 5.53	laubach_3ca_1_0118
					1.85 ⁵ (1.3 – 1.67) 2.11 ⁶ (1.48 – 1.9)			

¹ Electrical gain over RS(255,223) of 7.1 dB. Optical gain is 0.7 to 0.9 * NECG.

² Capped at 15 iterations

³ With interleaver, precoder off

⁴ With interleaver, precoder on

⁵ No interleaver, precoder off

⁶ No interleaver, precoder on

⁷ Omitted from laubach_3ca_1a_1117

Rev 1a updated values.

FEC Encoder Draft Text

- Proposed draft text for FEC encoder is in han_3ca_2_0118.docx.
- Description style based on ITU-T G.9960.
- Parity code H_c matrix is provided in han_3ca_1_0118.txt for inclusion in the draft (if a separate file is needed for publication as was done in Clause 55A).

Proposed motion

- Adopt the draft text in “han_3ca_2_0118.docx” for the downstream FEC with editorial discretion to include the file “han_3ca_1_0118.txt” if required for publication of the standard.

Thank you



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